Environmental Impact Assessment: Dominica

Hurricane Lenny Recovery in the Caribbean

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Executive Summary

The construction of retaining walls with armour stone revetments at the Cabrits Junction and Cabrits Access roads on the northwest coast of Dominica is expected to provide significant long-term improvements to the stability and integrity of the shorelines and roadways at both locations. The implementation of this coastal protection design option is also expected to offer long-term benefits to pedestrian and vehicular safety and access at both sites.

A summary of the impacts during construction and long-term operation is provided in the form of an impact matrix, which is attached as Appendix 1.

The evaluation of impacts associated with the construction indicates that the most significant negative impacts will be the impairment of access and safety for vehicular and pedestrian traffic during the site preparation and construction activities. These impacts are generally medium-term, and may be mitigated by effective scheduling and the use of appropriate traffic management and control measures.

Significant terrestrial habitats in close proximity to the project area are the Cabrits National Park and a large coastal wetland at the Cabrits Junction site. It is not expected that the proposed coastal rehabilitation activities will have any significant adverse effects on these habitats.

At the Cabrits Junction location, no significant fish or floral population assemblages were observed within the nearshore zone. Sensitive habitats are sufficiently far offshore so as not to be negatively impacted by construction and operation of infrastructure at the site, if adequate mitigation measures are implemented. At the Cabrits Access location, boulders in the nearshore environment support a mixture of juvenile and mature coral species. During construction, care should be taken to implement mitigation measures in order to avoid severe negative impacts on this sensitive habitat.

Sea-bathing and fishing do not occur within the designated project areas, and are therefore not expected to be adversely affected by the rehabilitation activities.

1. Objectives

The principal objective of this assessment is to outline and evaluate the environmental impacts, and to recommend mitigation strategies, for the proposed coastal road remediation and sea defence works along the Cabrits Junction and Cabrits Access roads on the northwestern coast of Dominica. The remedial works are proposed as a direct response to the coastal damage and increased shoreline vulnerability resulting from the impact of the storm-generated energy waves associated with the passage of Hurricane Lenny in November 1999.

2. Site Description

2.1 Description of General Area

The project site occurs along the northwestern coast of the island of Dominica, immediately north of the town of Portsmouth (see Figure 1). The proposed work is divided into two sections. The first section occurs at Cabrits Junction, along a stretch of coastal road approximately 80m long, towards the northern extreme limit of the beach known locally as the Purple Turtle Beach. The second section is a stretch of coastal road, between 300m and 400m in length, located along a coastal road known as the Cabrits Access Road. This road runs along the shoreline of the Cabrits Headland.

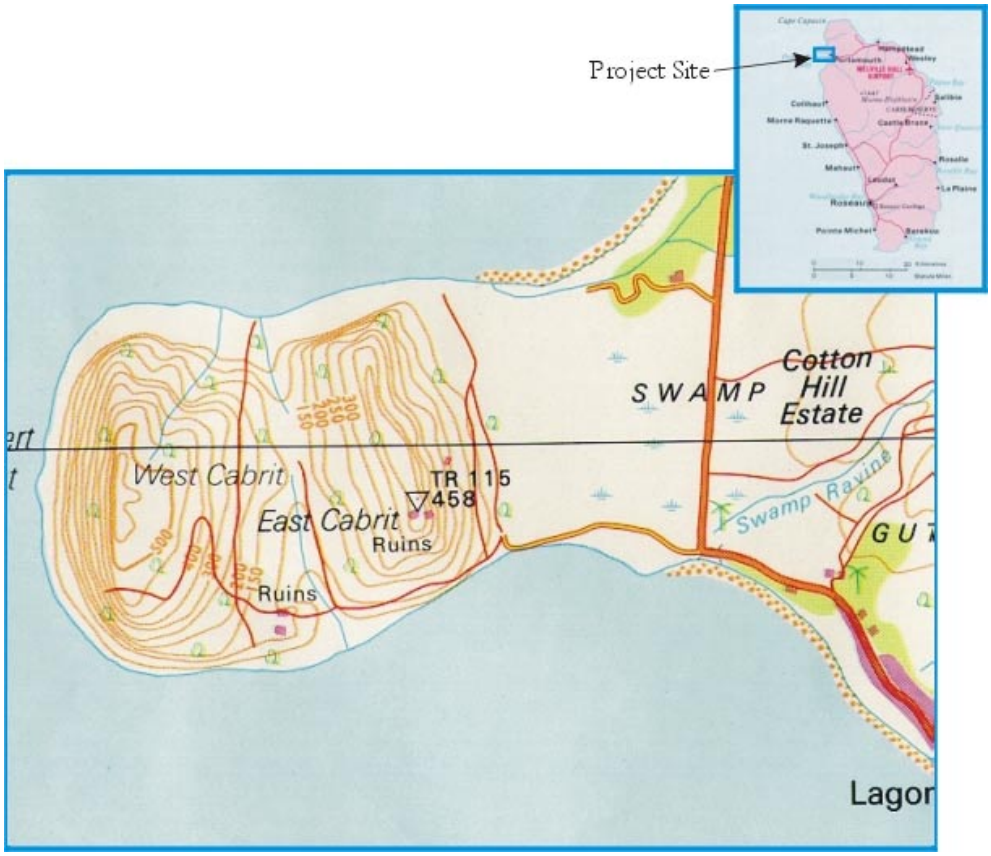


Figure 1 Site location map

Figure 2 shows the bathymetry offshore at both Cabrits Access and Cabrits Junction sites.

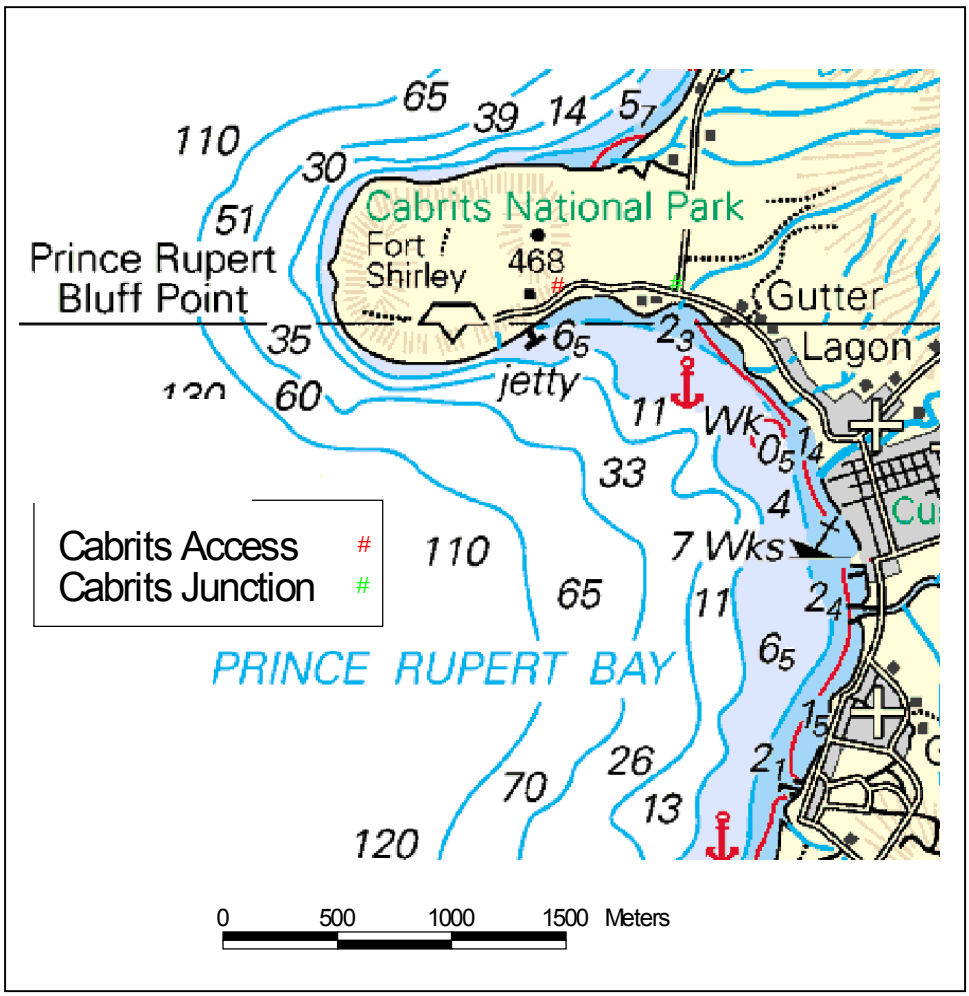


Figure 2 Offshore bathymetry at site

2.1.2 Cabrits Junction

This site is a T-junction where a smaller secondary (West to East) landward access road, joins the main (North to South) coastal road (see Photos 1 and 2). This road section forms part of a coastal highway encircling most of the island. It is a main transportation route between Portsmouth and Cabrits National Park, as well as communities further to the North. Alternative access routes are not easily accessible.

A coastal wetland, the largest of its kind in Dominica, occupies the landward side of the road. Overland flow is channeled seawards via a concrete box drain and culvert into a small river course/ravine. The river course then discharges onto the beach at a location close to the northern end of the project site. A second culvert, that occurs further south, provides additional drainage for the landward area.

PVC conduit pipe occurs along the landward edge of the road. This conduit houses wires for electricity and telephone connections in the area.

Photo 1 Cabrits Junction looking north towards ravine

Photo 2 Cabrits Junction looking south

The seaward side of the existing coastal road is protected in part by a short length of reinforced concrete wall and a gabion basket structure. The gabion baskets appear to have been placed in order to provide either a footing or toe protection for the wall. During the passage of Hurricane Lenny in 1999 both of these structures failed. The baskets have been severely ruptured with stones escaping and the wall has been undermined. This has resulted in the erosion of exposed road substrate materials. The exposed wires of the broken gabion

baskets now pose a hazard to public health and safety. Damage to the wall has resulted in a loss of protection of the roadway from periodic high-energy wave attack.

The majority of the remaining road edge lacks any structure to retain fine materials used in the road's sub-base. Consequently, under exposure to high-energy wave attack, fine material has been removed from the sub-base. The road has been undermined and significant erosion of the edge of the road has occurred. There has also been some encroachment of vegetation on the edge of the road.

The beach bordering the road varies in nature from sandy to cobble beach. Recreational use is made of the Purple Turtle beach just south of the project area. This beach is popular for sea-bathing and swimming, especially on weekends and public holidays. Due to a lack of parking capacity, particularly during peak use periods, users of the beach reportedly park vehicles on both sides of the road in the area south of the project site, or alternatively within Portsmouth and proceed to the beach on foot.

Seine fishing also occurs in the coastal region just south of the project area. However, neither the recreational nor the fishing uses extend as far north as the project area itself.

An old wooden-hulled schooner, apparently derelict, is resting on the sandy beach at the southern end of the project area, approximately three to five metres from the seaward edge of the roadway.

2.1.3 Cabrits Access Road

This section of the project site is a 300-400m stretch of road located to the northwest of Cabrits Junction (see Photos 3 and 4). The road is the main access to the Cabrits Cruise Ship Berth/Jetty and the Cabrits National Park. Alternative routes are not easily accessible. Cabrits, which became part of the National Parks System in 1986, is a unique protected environment in Dominica. The park encompasses both terrestrial and marine habitats. The land-based area of the park includes forested areas, swampland, and a small mangrove stand, and serves as a habitat for a variety of fauna, including several species of migratory birds, and the endangered Sisserou Parrot. The Park also includes several hiking trails. Part of Douglas Bay, just north of the Cabrits headland, forms the marine section of the Park, where a marked marine underwater trail provides snorkeling and diving opportunities. The Park also has major historical significance, as the site for the ruins of Fort Shirley, constructed between 1770 and 1815. The National Park and associated amenities, including a recently constructed Visitor Centre and Museum, are a very popular visitor attraction, and can be considered a significant component of Dominica's tourism product. The Cabrits Access Road is the primary land-based access to the park.

No significant historic traffic count data for the Cabrits Access Road was available for analysis.

At this location, the road is approximately 3-5m above mean sea level. The landward side of the road is characterized by the presence of a steep, high cliff, running along the edge of the road. This cliff is part of the Cabrits National Park. The cliff ranges in height from approximately six to eight metres, with a slope of about 1:1. It consists of loose, unconsolidated materials, and is topped with mature vegetation.

There is no beach along the seaward edge of the road at this location.

Photo 4 Cabrits Access road looking east

Photo 4 Cabrits Access road looking west

It appears that during the "cutting"/construction of the Cabrits Access road, excavated material from the existing cliff that was terraced to accommodate the road, was placed along the seaward edge of the road in an effort to provide some protective armouring against wave action. Additionally, this material may also have been supplemented by the placement of rock armouring from other locations.

The steep slope at which this material was placed and irregular packing has proven unstable under the impact of high-energy waves. Boulders appear to have rolled from the toe of the seaward slope of the road and have subsequently moved offshore.

Much of the seaward edge of the road has been severely eroded and undermined. The road is irregularly pocketed by erosion, and in some places the road width has become dangerously narrow, with as much as 3m lost from the seaward edge.

2.2 Description of Baseline Environmental Conditions

2.2.1 Cabrits Junction

Nearshore waters appear slightly turbid, probably due to the fact that the small river course that drains the swamp discharges into the nearshore environment. At this location, some ponding of water occurs, with the water appearing stagnant and turbid. The presence of green filamentous macroalgal growth on the cobble rocks in the nearshore suggests eutrophication of the water. The high nutrient content of the water is probably associated with the drainage/discharge from the swamp and indirectly from higher relief upland agricultural areas that drain into the swamp.

No significant historic baseline marine water quality data appears to be available for the project site. A single shot sampling and analysis episode was undertaken for one nearshore location at mid-site. Samples were analyzed for total suspended solids (TSS), nitrates, phosphates, faecal coliform and faecal streptococcus. Samples were analyzed by the laboratory of the Environmental Health Department, the Ministry of Health, Commonwealth of Dominica. Results are presented in Table 1 following. The offshore station for this site is the same as the Cabrits Access Offshore station that is presented in Table 2.

Table 1: Summary of Single Episode Water Quality Sampling Results for Nearshore Station at Affected Project Site

	Nearshore Station	Recommended Standards	Source
Total suspended solids	279mg/l	4.0mg/L	
Nitrate	1.1mg/L	0.0098mg/L	USEPA (1992)
Phosphate	0.06mg/L	0.0014mg/L	USEPA (1992)
Faecal Coliform (FC)	Tested negative for this parameter	Geometric mean should not exceed 200 colonies per 100ml	USEPA (1992)
Faecal Streptococcus (FS)	Tested negative for this parameter	Geometric mean should not exceed 35 colonies per 100ml	USEPA (1992)

Turbidity levels, as indicated by TSS concentrations, were found to be almost 70 times the recommended threshold level. Levels of phosphates and nitrates also significantly exceed recommended threshold levels for marine ecosystem health. Nitrate levels are 112 times higher than levels recommended for marine waters. Phosphate levels are also significantly higher (approximately 42 times) than recommended threshold levels. With respect to bacterial levels, analysis of the sample rendered it negative for both faecal coliform (FC) and faecal streptococci. The water bacteriology as it pertains to these two parameters is very good. The high nutrient (phosphate and nitrate) levels observed in the nearshore are consistent with, and probably attributable to, drainage from the swamp on the landward side of the road.

A baseline assessment of the nearshore benthic habitat offshore of Cabrits Junction and Cabrits Access was carried out by means of video monitoring and analysis. Video monitoring was undertaken for four 30m shore-perpendicular transects at a depth range of 3 to 5 metres. Positions of transects were selected so as to present a sufficient spatial range of coverage within a zone of likely project influence of any proposed works. The site specific locations of transects along reef were selected randomly.

The observer, swimming slowly, video recorded the substrate along each transect line. The video was then analyzed frame by frame using a random dot overlay technique[1], recording percentages cover for each of the following: live coral, gorgonians, sponges, turf algae, macroalgae, sediment/sand, dead coral/rubble, and overhangs/gaps/crevices. Coral species diversity and abundance were also recorded for each transect, in addition to grazing urchin abundance.

This method of marine community monitoring was selected over chain transect monitoring, due to its relative ease and rapidity of execution and generally as a consequence of the heavy surge experienced at the site, which would have prohibited accurate chain measurement. The advantage of a photographic record for future comparative analysis was also considered as a factor in selection. This assessment revealed that the nearshore zone consists entirely of bare, uncolonized, fine black/grey silty sand bottom habitat. No other significant habitat types were observed from underwater diving inspection to a distance of 50 metres from the mean high water mark.

Further offshore, in deeper water, occasional patch reefs and seagrass beds are reported as existing.

The predominant direction of littoral drift is from north to south.

2.2.2 Cabrits Access Road

Nearshore water appears clear. The level of macroalgal growth on nearshore rocks has been observed to be quite low. This phenomenon is probably attributable to the high level of flushing/agitation in the nearshore zone due to high surface circulation.

No historic baseline marine water quality data appears to be available for the project site. A single shot sampling and analysis episode was undertaken for one nearshore and one offshore location. Samples were analyzed for total suspended solids, nitrates, phosphates, faecal coliform and faecal streptococcus. Samples were assessed by the laboratory of the

[1] Methodology followed is the same as that promoted by Jeff Miller of the US Geological Survey, Biological Resources Division, USVI

Environmental Health Department, Ministry of Health, Commonwealth of Dominica. Results are presented in Table 2 following.

Table 2: Summary of Single Episode Water Quality Sampling Results for Nearshore and Offshore Stations at Affected Project Site

Parameter	Nearshore Station	Offshore Station	Recommended Standards	Source
Total suspended solids (TSS)	280mg/l	263mg/l	4.0mg/L	
Nitrate	1.0mg/L	1.8mg/l	0.0098mg/L	USEPA (1992)
Phosphate	0.01mg/L	0.03mg/l	0.0014mg/L	USEPA (1992)
Faecal Coliform (FC)	Tested negative for this parameter	Tested negative for this parameter	Geometric mean should not exceed 200 colonies per 100ml	USEPA (1992)
Faecal Streptococcus (FS)	Tested negative for this parameter	Tested negative for this parameter	Geometric mean should not exceed 35 colonies per 100ml	USEPA (1992)

Levels of turbidity (as indicated by TSS concentrations) were found to be high in the nearshore with a slight diminution in the offshore. Levels of phosphates and nitrates appear somewhat higher in the offshore than in the nearshore. At both stations, phosphate and nitrate levels significantly exceed recommended threshold levels for marine ecosystem health. Nitrate levels are 102 to 184 times higher than levels recommended for marine waters. Phosphate levels are also significantly higher (approximately 7 to 21 times) than recommended threshold levels. With respect to bacterial levels, analysis of both samples produced negative results for both faecal coliform (FC) and faecal streptococci, indicating that the water bacteriology as it pertains to these two parameters is good.

On the seaward side of the road, the boulder armouring (mentioned previously in Site Description) occupies the immediate nearshore. Seaward of the revetment, the nearshore is occupied by small cobble (<10kg), covered in turf algae. This is followed by a narrow band of bare grey silty sand (<5m wide). Approximately 30 to 50 metres from the seaward edge of the road are larger (two to five ton) rocks, which support some coral growth. Species of coral include brain coral (*Diploria* species), mustard hill coral (*Porites astreoides*), and encrusting fire coral (*Millepora* species). This growth is concentrated on the most seaward of this group of rocks.

Further offshore, approximately 50m from the seaward road edge, large (six to ten ton) boulders are present. These boulders are found at discrete intervals, rather than grouped together. It is possible that these are boulders that have rolled from the cliff top or dislodged from the armouring placed along the seaward road edge and been carried offshore. These boulders support a mixed population of juvenile and mature coral formations,

primarily brain coral (*Diploria* species), mustard hill (*Porites astreoides*), and encrusting fire coral (*Millepora* species).

The video monitoring and analysis technique described in Section 2.2.1 above was also used to assess the baseline nearshore benthic habitat at the Cabrits Access location. The resulting data is presented in Tables 3, 4 and 5.

Table 3: Percentage cover by substrate type for each survey Transect

	Transect 1 (~mid-site road culvert)	**Transect 2 (~50m west of Transect 1)**	**Transect 3 (~150m west of Transect 2)**
Percentage cover live coral	8.7	5.0	4.5
Percentage cover dead coral/rubble	0	0	0
Percentage cover Sediment/sand	27.5	38.7	36.5
Percentage cover turf algae	52.8	54.0	48.1
Percentage cover Macroalgae	3.7	0.9	0.4
Percentage cover Calcareous algae	4.2	0.9	8.1
Percentage cover Sponges	0.2	0	0.2
Percentage cover gorgonians	1.7	0.4	1.6
Percentage gaps Overhangs etc.	0	0	0
Percentage other e.g. transect line	0	0	0.9

Table 4: Urchin Abundance between Transects

	Transect 1 (~mid-site road culvert)	Transect 2 (~50m west of Transect 1)	Transect 3 (~150m west of Transect 2)
White Sea Urchin Tripnuestes ventricosus	0	0	0
Black Sea Urchin (Diadema antillarum)	2	0	15

Table 5: Coral Species & Number of Colonies per Survey Transect

Coral Species	Transect 1 (~mid-site road culvert)	Transect 2 (~50m west of Transect 1)	Transect 3 (~150m west of Transect 2)
Colpophyllia natans	0	0	2
Dilporia labyrinthiformis	0	2	1
Diploria strigosa	14	12	7
Meandrina meandrites	1	0	0
Millepora alcicornis	9	10	5
Millepora complanata	1	0	0
Montastrea annularis	2	0	0
Porites astreoides	21	3	16
Porites porites	2	1	8
Siderastrea radians	2	0	0
Siderastrea siderastrea	2	1	2
Total No. Coral Species per transect	9	6	7
Total No. Coral Colonies per transect	63	35	48

Generally, from the survey results it can be seen that nearshore habitat at the Cabrits Access site is characterized by low relative percentage live coral cover (<10%). Habitat cover is dominated by a high percentage of turf algae (closely approaching or in excess of 50% of total habitat cover) for all transects surveyed. Cover by sediment/sand is the second most dominant category of habitat coverage. Percentage cover by macroalgae, calcareous algae, gorgonians and sponges was generally low.

Percentage live coral cover diminishes closer to the shoreline in the vicinity of the existing jetty. The transect data demonstrates that coral cover appears highest in the nearshore in the middle section of the Access road, but declines westward.

Grazing urchin abundance is generally low for all transects, with the exception of transect 3, where 15 specimens of *Diadema* were recorded (Table 4).

Generally, Mustard Hill (*Porites astreoides*), Symmetrical brain coral (*Diploria strigosa*), and Branching fire coral (*Millepora alcicornis*) were the most dominant coral species encountered, in diminishing order of dominance (Table 5).

From visual observation, nearshore habitat is not true reef, but consists of corals that have recruited onto boulders and cobble that has been displaced into the immediate nearshore. Coral formations generally begin to be observed along transects at a distance ranging between 12 to 15 metres from the seaward toe of the existing armour stone revetment along the Access road. The habitat appears to be functioning as grazing habitat for migratory herbivorous reef species as well as having some nursery role. A mixture of both juvenile and mature coral species was observed

Dispersed patch reefs and seagrass beds are reported for the offshore.

The predominant direction of littoral drift is from north to south.

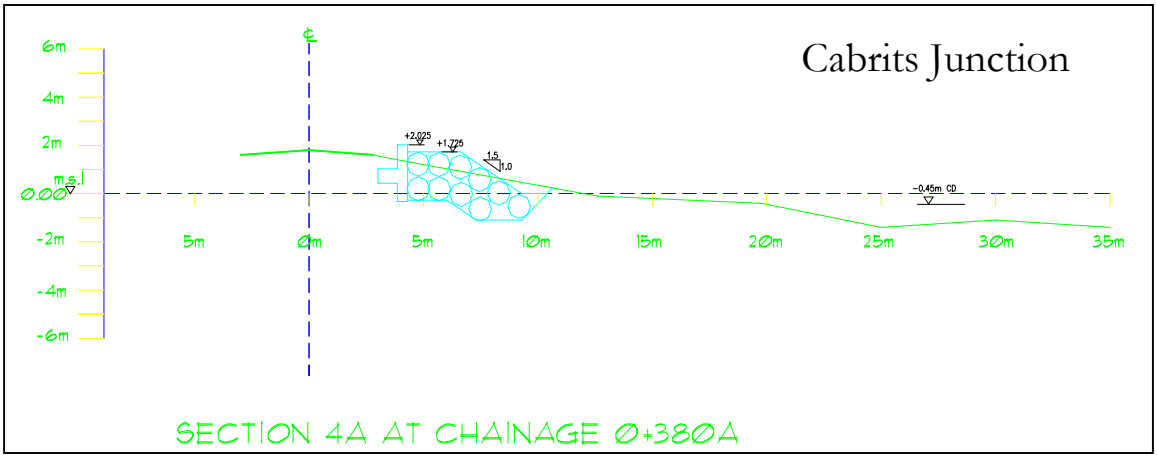
3. Options for Remediation

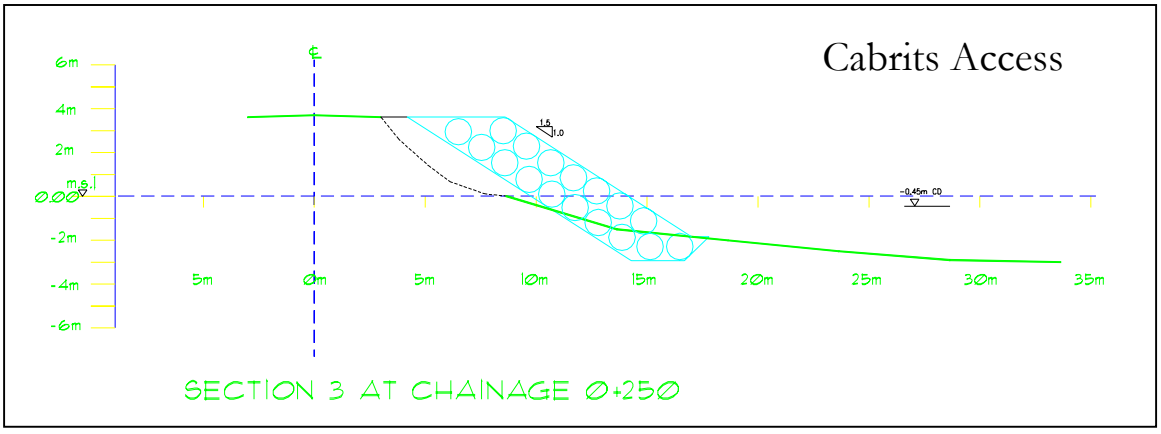
Several alternative techniques are available for effecting remediation at the project sites. These include: retaining walls, seawalls, revetments, retaining walls with toe protection, seawalls with toe protection, or combinations of the above.

3.1 Preferred Option

Of these options, a combination of reinforced concrete retaining wall fronted by an armour stone revetment will provide both the Cabrits Junction and Cabrits Access roads, associated structures, and shoreline with the most cost effective, maximum enduring protection against high-energy wave events. The retaining wall with revetment is assessed with respect to potential environmental impacts, in the subsequent section 4.0.

Cross sections of the revetments and seawalls for Cabrits Junction and Cabrits Access are shown in the following figures.





3.2 No-Action Option

Should no remedial action be implemented, it can be expected that the current threat to the integrity of the road structure at both locations will continue. Erosion, undercutting and destabilization of the road will persist. Exposure to future high-energy wave events may lead to seaward collapse of the road. In such a worse case situation, traffic along the road may be disrupted, completely severing the primary traffic connection between Cabrits and Portsmouth for several days to weeks. Such a severance would cause a diminution in the recreational use of the Purple Turtle Beach, and would also induce a fall off in economic activity/profitability of the Cabrits National Park.

The "do nothing" alternative is expected to involve a major negative impact on the pedestrian and vehicular access and safety. The hazards that currently exist for pedestrians and drivers along the Cabrits Junction and Cabrits Access due to the damaged roads would be exacerbated by the continued deterioration of the roadways.

The further continued failure and seaward collapse of the roads as a result of a lack of remedial action is not expected to have a major impact on coastal processes, e.g. sediment transport, wave processes and current circulation.

However, the persistent leaching of fines and particulate materials from the exposed road base into the nearshore would be likely to cause an increase in the turbidity of the nearshore waters at both locations. This would have a significant adverse medium term impact on nearshore water quality, primarily as a consequence of the generation of a turbid plume. The effect would be expected to be minimal to moderate with respect to offshore water quality.

A "no remedial action" worst-case road failure scenario is not likely to generate any significant negative impacts to benthic marine and/or terrestrial communities/habitats for the Cabrits Junction, as there are no existing significant nearshore benthic habitats to be impacted.

There is the potential for some mortality or stress impact to coral habitats that occur in the nearshore zone along the Cabrits Access Road project site. Offshore benthic habitats i.e. patch reefs and seagrass beds, are located sufficiently far offshore, so as not to be affected.

The designated terrestrial and marine habitats of the Cabrits National Park and the swamp at Cabrits Junction are not expected to be impacted by the failure of the Cabrits Junction and/or Cabrits Access roads.

4. Environmental Consequences of Preferred Options

4.1 Site Preparation & Construction Impact Analysis

Site preparation and construction is expected to involve the following sequential stages at the two locations:

At Cabrits Junction

- removal of boat from beach;
- material stockpiling;
- demolition/clearance of existing concrete wall, culverts and gabion baskets;

- retaining wall and culvert construction;
- beach/nearshore excavation;
- geotextile placement
- secondary layer placement
- primary layer armour stone placement;
- roadway reconstruction (spot repair, grading & re-surfacing) and realignment of junction.

At Cabrits Access

Site preparation and construction is expected to involve the following stages:

- material stockpiling;
- excavation/removal/regrading/reshaping of existing revetment;
- retaining wall construction;
- geotextile placement
- secondary layer placement
- new armour stone placement and
- road spot repair, surface elevation and re-surfacing.

The following key terms are defined for the analysis of environmental consequences during site preparation, construction and infrastructure operational phases. The EIA Matrix for this site is attached as Appendix 1.

Short term (**ST**): refers to "hours to days" duration of impact

Medium term (**MT**): refers to "days to weeks" duration of impact

Long term (**LT**): refers to "weeks to months" duration of impact

Minimal effect: refers to a low magnitude, easily reversible, small spatial scale, minimum impact effect

Moderate effect: refers to an intermediate magnitude impact, moderate spatial scale; can be mitigated with some effort

Significant effect: refers to a high magnitude, potentially immitigable, large spatial scale, maximal impact effect

No effect expected

Significant positive effect

4.2 Cabrits Junction

4.2.1 Removal of Boat from Beach

Two alternatives are available for the removal of the boat. The vessel can be pulled offshore by means of a towing system using another boat or a barge, after which it can be scuttled at sea at an appropriate location. This option is only feasible if the boat is in good condition,

and is able to float. Alternatively, the boat can be broken up on site, and the pieces removed manually to an approved disposal site. The option of manual removal option could be more easily and cost effectively achieved and is therefore preferable to towing and offshore scuttling.

The removal of the boat is not expected to have any significant negative impact on the coastal oceanographic processes, natural environment/habitat, built environment or social uses.

Nearshore circulation, longshore drift, wave processes and water quality are not expected to be impacted by the removal of the boat.

During the process of loading the fragments of the boat onto vehicles for transportation from the site, there may be some minor disruption of vehicular and pedestrian traffic on the seaward side of the road.

Noise emission in dismantling the boat may be moderate. However, the site is sufficiently distant from any populations that would be potentially disturbed by the nuisance factor.

The removal of the boat from the shore would improve the visual aesthetics of the project area. However, if all debris is not removed from the site, remaining fragments may prove to be an eyesore. Further, debris left on the beach may be carried offshore and transported along the coast, where it may be a hazard to users of nearby beaches.

Recommended Mitigation

- Manually dismantle and completely remove the boat from the beach.
- Schedule the removal of the boat for completion in the minimum time possible.
- Dispose of debris in an environmentally sound manner at the closest Government approved solid waste disposal site.
- While the boat is being dismantled, erect signage to inform road users (drivers & pedestrians) that work is in progress and that appropriate safety measures should be taken.
- Provide personnel to temporarily direct vehicular and pedestrian traffic safely.

4.2.2 Material Stockpiling

It will be necessary for both armour stone and fill materials to be transported from remote quarry sites and stockpiled on site for use. The armour stone will be conveyed to the site either by barge or by truck depending on the quarry location.

Should the barge option be necessary, a temporary landing ramp will have to be constructed out from shore. Construction of the landing ramp will not significantly impact benthic communities, as no major ones exist in the nearshore.

Construction of the landing ramp may contribute to a further decline in nearshore water quality at the Cabrits Junction location, depending on substrate materials used in construction of the ramp and the treatment of such materials. If fine materials are used, a nearshore sediment plume may potentially develop. No other significant water quality impacts from temporary ramp construction are anticipated.

Construction of the ramp may also induce some short-term groyne effect, by trapping littoral sediment drift.

At the conclusion of this activity, the landing ramp will be dismantled. Improper disposal of the materials used to construct the ramp has the potential to adversely affect the visual aesthetics of the disposal site. If the materials are disposed of in a sensitive habitat, whether terrestrial or marine, significant negative impacts on that habitat and associated communities may be expected.

The use of barges to transport materials to the site is preferable to the use of trucks. In order to reach the project location, trucks would have to travel via the Portsmouth Bridge, located to the north of the project site. The weight of the vehicles under load that would be necessary to transport the construction materials may cause damage to this bridge, which was not designed to support such heavy vehicular traffic.

Should materials be transported to the site by truck, the associated increase in vehicular traffic on the route would be expected to have some impact on drivers, pedestrians and their safety, particularly given the decreased width of the roadways. It is expected that pedestrians would be more severely affected than vehicular traffic.

Increased noise and dust levels are expected to be associated with the use of the road by the heavy freight trucks that would be necessary to transport the materials. The increased noise and dust may have some nuisance effect on road users.

Localized, moderate medium term disruptive impacts are expected with respect to pedestrian access and safety as well as vehicular access and safety in the vicinity of the designated stockpile zone. Given the limited availability of space at the site, the most feasible location in which to stockpile the material is on the beach to the south of the project site, in the area currently occupied by the derelict boat. Such a location would allow adequate space for the materials to be stored, and would also permit easy access by either barge or truck. In addition the location is the property of the Commonwealth of Dominica and therefore could be easily made available for use.

The actual storage/stockpiling and stockpiling activity is not expected to generate any significantly negative, persistent (long term) or spatially extensive impacts on the coastal oceanographic processes, and/or built environment.

Negligible impacts to nearshore circulation, longshore drift and wave processes are expected from material stockpiling.

The potential for some moderate short-term impairment of nearshore water quality exists only in the event of heavy rainfall and consequent leaching of runoff from designated stockpile zones. Such impact would be primarily in the form of increased water column turbidity due to sediment loading.

Impacts to offshore water quality are expected to be minimal and short term if runoff from stockpile areas takes place.

As there are no significant existing viable benthic marine communities within the immediate nearshore, no impact from material stockpiling and/or potential runoff is expected. Only minimum, short-term negative impacts, if any, to offshore benthic communities are expected. Such impacts would be due to stormwater runoff from the material stockpile.

The probability of this type of impact is low, especially given the distance from shore where viable offshore habitat begins to occur.

Fishing and recreational beach use will be unaffected, as these activities are not undertaken within the immediate area of the project site.

Stockpiling can be expected to produce moderate medium-term impacts with respect to the generation of noise, dust and vibration. Noise and vibration are unavoidable. However, since most residential communities are some distance away from likely stockpile zones, these impacts are not expected to be significant.

Stockpiling will impact negatively on the visual aesthetics of the project site in the medium term for the duration that the armour stone and road fill/bedding material remains in place.

Recommended Mitigation

- Transport materials to the project area via barge.
- If materials are transported to the site via truck, the bridge in Portsmouth would have to be structurally fortified.
- Erect temporary signage alerting road users that heavy freight vehicles are using the road, and that appropriate safety precautions should be taken. Pedestrian traffic should also be contained behind a separating temporary protective barrier/screen to reduce potential pedestrian/vehicular contact.
- If a landing ramp is required due to barge transport of material to site, construct ramp with large pre-washed stone, rather than with fine particle substrate materials. Materials should be washed in order to remove fine/particulate surface adhering material prior to deployment/use.
- In the event that a landing ramp is required, the armour stone used to build it should, wherever possible, be utilized at the construction site as part of the rock armouring protection of the seawall. If reuse in this or other construction projects is not feasible, the material should be disposed of appropriately at a Government approved disposal site.
- When the landing ramp is dismantled, any structural fill is used in its construction should be excavated and disposed of at the closest disposal site approved by the Government of Dominica.
- If fine particle substrate materials are used to construct the temporary ramp, the edges must be contained with a geotextile, to prevent leaching of fine material into nearshore waters.
- Groyne effect of ramp can be minimized if ramp does not extend more than 15-20 metres from the shore, if loading and shore transfer of material is undertaken swiftly and if the ramp is removed quickly after all required material is stockpiled on site.
- Optimize construction schedule to minimize residence time of material stockpile on site.
- Surfaces of stockpiled rock for bedding layer can be periodically wetted to reduce suspension of fines by wind.

4.2.3 Demolition/clearance of existing concrete wall, culverts and gabion baskets

The existing concrete wall and gabion baskets will have to be removed from their location on the seaward edge of the road. In addition the culvert headwalls will be demolished. After demolition, the rubble generated will be cleared from the site and disposed of at an approved location. This demolition is not expected to generate any significantly negative, persistent (long-term) or spatially extensive impacts on coastal oceanographic processes or the natural environment.

Some minimum short-term contribution to a decline in nearshore water quality is expected as a result of demolition and removal of the structures from the seaward road edge. This will largely be as a result of sediment suspension as a result of some bottom substrate agitation. The impact will be minimal and will only persist for the duration of the activity.

Negligible impact is expected to offshore water quality, as demolition will be a short duration, localized and a spatially small-scale activity.

As there are no significant existing viable benthic marine communities within the immediate nearshore area, no habitat loss or mortality impact from demolition is expected.

Demolition is expected to have some significant negative short-term impact on both pedestrian and vehicular safety and access along the seaward fronting lane of the existing road. Access along this section of the road will be obstructed for the duration of the activity.

Demolition works along the Cabrits Junction road may also affect access, for both visitors and locals, from Portsmouth to the Cabrits National Park. Access is likely to be impaired but not severed. Impaired access may influence the number of visitors to the Park.

Recreational beach use may be minimally affected by the demolition of the seawall and gabion structures, as access to and parking for the popular Purple Turtle Beach may be slightly reduced. Fishing does not occur close enough to the project area to be adversely affected by the demolition works.

The visual aesthetics of the project site will suffer moderate negative impacts due to the demolition works. If materials from the demolition activity are not disposed of in an adequate manner, they may present an aesthetic and environmental problem at the disposal location.

The demolition process should not adversely affect the utilities services provided by the cables housed in the roadside conduit.

Recommended Mitigation

- Contain pedestrian access to the landward side of the road, behind a separating temporary protective barrier/screen, to reduce potential pedestrian/vehicular contact.
- Restrict traffic along the Cabrits Junction road to a single lane on the landward side of road.
- Control traffic flow either manually or automatically with temporary traffic lights at both ends of affected stretch of road, restricting traffic to a single lane of flow and ensuring smooth, manageable, safe vehicular movement.

- Optimize the construction schedule to minimize the duration of disruption of access to and from Cabrits and Portsmouth.
- All demolition/construction debris should be discarded in an acceptable manner at a site approved for the disposal of this type of waste.

4.2.4 Retaining wall and culvert construction

The retaining wall and culverts at the Cabrits Junction location will be poured concrete structures.

Forms will be constructed or placed on site. Concrete will then be poured into the forms, which are removed several days later. When complete, the wall will serve to retain the composite fill of the road, thus maintaining the integrity and consistency of the road's surface and sub-base. The new culvert will serve to maintain the existing drainage from the landward swamp to the nearshore region. The retaining wall structure will be additionally protected by a partly buried, sloping armour stone revetment, which will absorb and dissipate the impact forces of incident waves.

Retaining wall construction is not envisaged to induce any significant negative impact to circulation, wave processes or longshore drift. Further, no impacts to benthic marine communities are expected as none exist in the nearshore and those in the offshore are sufficiently far away to not be affected.

Some potential for localized, short-term, moderate impact to nearshore water quality exists, should there be any escape/leaching of concrete from the mould during casting. However, the probability of this occurring is quite low.

No significant impacts to offshore water quality are expected as a consequence of wall construction.

Significant medium term impact to both vehicular and pedestrian traffic and safety along the Cabrits Junction road are expected as a result of wall construction. Concrete trucks will cause disruptions, particularly during pouring. In addition the noise and vibration generated by the trucks may have some nuisance effect to road users.

Impacts on surrounding terrestrial habitats will be negligible.

The retaining wall will provide significant long-term positive impact to shoreline integrity and stability.

Recommended Mitigation

- Vigilant inspection during concrete pouring to prevent "overpouring/overfilling"
- Contain pedestrian access to the landward side of the road, behind a separating temporary protective barrier/screen to reduce potential pedestrian/vehicular contact.
- Restrict inbound and outbound traffic along the Cabrits Junction road to a single lane on the landward side of road.
- Control traffic flow either manually or with well synchronized temporary traffic lights at both ends of the affected stretch of road, restricting traffic to a single lane to ensure smooth, manageable, safe vehicular movement.

- Provide an elevated sidewalk alongside the crest of wall with railings for future pedestrian alongshore access. This will protect the long-term safety of pedestrian traffic, which is especially heavy during the holiday periods when the Purple Turtle Beach is heavily used.

4.2.5 Beach/Nearshore Excavation

Some minor excavation may be required in the beach in order to facilitate the proper placement of the geotextile, secondary stone layer, protective toe armour stone and to ensure that design grades for the protective revetment structure are achieved.

Excavation is not anticipated to generate any significant negative impacts to circulation, longshore sediment transport and wave processes, as the excavation activity is expected to be on a limited spatial scale.

Some moderate, direct decline in nearshore water quality can be expected over the short term if this activity is required. The further potential decline in nearshore water quality will be as a result of the agitation of nearshore bottom substrate and the suspension of fine fraction sediments

A slight short-term decline in offshore water quality may be expected if the nearshore plume from excavation moves offshore. However, the probability of this occurring is low.

There are no significant benthic marine communities existing within the nearshore zone in the vicinity of any likely excavation.

Offshore benthic marine communities (i.e. seagrass and patch reef habitats) are generally sufficiently far away from the zone of likely excavation so as not to be significantly negatively impacted. Offshore communities may only be indirectly impacted, minimally for short duration if the nearshore plume from excavation moves offshore. The potential for this is low.

No impact on terrestrial habitats is expected from the excavation activities.

Excavation, if required, is expected to have significant negative short-term impact on both pedestrian and vehicular safety and access along the seaward fronting lane of the existing road. Access along this section of the road will be periodically obstructed by the movement of excavation equipment, for the duration of the activity.

Recommended Mitigation

- Monitor nearshore plume formation and offshore (400 m from seaward road edge) migration. Should a persistent plume develop and move offshore rapidly, excavation activity should be temporarily ceased until plume abates.
- Contain pedestrian access to the landward side of the road, behind a separating temporary protective barrier/screen to reduce potential pedestrian/vehicular contact.
- Restrict traffic along the Cabrits junction road (into and out of Portsmouth) to a single lane on the landward side of road.
- During construction, control traffic flow either manually or with temporary traffic lights at both ends of the affected stretch of road, restricting traffic to a lane and to ensure smooth, manageable, safe vehicular movement.

4.2.6 Geotextile Placement

Prior to the deposition of stone material to create the revetment, a layer of geotextile material will be laid along the seabed in the immediate nearshore. This geotextile layer will extend from the base of the retaining wall to the toe of the revetment. It provides a barrier between the fine sediments of the seabed and the overlying layers of stone, thus inhibiting the movement of fines from the base of the revetment, and preventing excessive settlement of the revetment.

The laying of the geotextile materials is not expected to cause any significant negative impacts on circulation, longshore sediment transport or wave processes.

No significant disturbance of bottom substrate or suspension of fine particles in the nearshore environment is expected as a result of this activity. Hence, impacts on nearshore water quality, if any, are predicted to be short-term and minimal.

No impacts on offshore water quality are expected as a result of this activity.

Benthic marine communities and habitats are expected to be unaffected by this activity.

The installation of the geotextile layer is expected to have moderate negative short-term impact on both pedestrian and vehicular safety and access along the seaward fronting lane of both of the existing road, due to some obstruction of access for the duration of the activity.

Sea-bathing and fishing do not take place in the project area and will be unaffected by the placement of the geotextile layer.

The visual aesthetics of the project area will suffer some minimal short-term impact for the duration of this activity.

In the long-term, the placement of the geotextile layer will have a positive effect on shoreline stability and integrity.

Recommended Mitigation

- Contain pedestrian access to the landward side of the road, behind a separating temporary protective barrier/screen to reduce potential pedestrian/vehicular contact.
- Restrict traffic along the Cabrits Junction road (into and out of Portsmouth) to a single lane on landward side of road.
- Control traffic flow either manually or with temporary traffic lights at both ends of affected stretch of road, restricting traffic to a single lane to ensure smooth, manageable, safe vehicular movement.

4.2.7 Secondary Layer Deposition

At the Cabrits Junction location, a secondary base layer of 100-700kg stone will be deposited as a precursor to the construction of either a benched or simple sloping armour stone revetment.

This layer will extend from the seaward edge of the road into the immediate nearshore. This layer will then be subsequently over-laid by layers of larger 3-5 tonne protective armour stone units. This bedding layer will also serve as a temporary pad, which the excavator and/or crane can usedto deploy and pack armour stone units.

Secondary layer deposition is not predicted to cause any significant negative impacts to circulation, longshore sediment transport and wave processes, as this activity is of a limited spatial scale.

Some moderate medium term impact to nearshore water quality is expected as a result of the washing off and suspension of fine particulates from the surface of the secondary stone layer material. There is a likely potential for a plume to develop within the immediate nearshore. This plume is likely to persist for as long as it takes for surface fines to be removed and dissipate.

Impact to offshore water quality is expected to be minimal and short term.

No mortality due to physical displacement and/or smothering is expected to coral reefs or seagrasses, as none of these significant habitat types exist in the immediate nearshore area.

Offshore benthic marine communities/habitat are generally, sufficiently far away from the zone of secondary layer stone placement so as not to be directly negatively impacted. Minimal short-term indirect impact to offshore seagrass is only likely if any nearshore plume that develops moves offshore. The probability of this occurring is extremely low.

Secondary layer stone deposition is expected to have significant negative medium term impact on both pedestrian and vehicular safety and access along the seaward fronting lane of both of the existing road, as access will be obstructed for the duration of the activity.

Some direct, moderate medium term impact to visual aesthetics is also likely.

During secondary layer deposition, the weight of heavy dump trucks transporting the stone may potentially induce damage to the seaward road edge.

Recommended Mitigation

- Contain pedestrian access to the landward side of the road, behind a separating temporary protective barrier/screen to reduce potential pedestrian/vehicular contact.
- Restrict traffic along the Cabrits Junction road (into and out of Portsmouth) to a single lane on landward side of road.
- Control traffic flow either manually or with temporary traffic lights at both ends of affected stretch of road, restricting traffic to a single lane to ensure smooth, manageable, safe vehicular movement.

4.2.8 Armour Stone Placement

A secondary layer of small armour stone (100-700kg) will first be laid down, followed by a layer of larger, primary (3-5T) armour stone units at an approximate slope of 1:2.

It is expected that stones in the most seaward zones will be placed by a crane or excavator, working backwards to the road.

Armour stone placement is not envisaged to induce any significant negative impact to circulation, wave processes or longshore drift. It will provide positive long-term benefit with respect to shoreline stability and integrity as well as wave energy dissipation. No impacts to benthic marine communities/habitats are expected.

Some localized impact to nearshore marine water quality may be expected from the suspension of fine surface adherent particulates when stones are deployed, close to the water

line. This is expected to be of short duration and minimal effect. No significant impact to offshore marine water quality is expected.

The main likely impacts arising out of armour stone placement will be to pedestrian and vehicular safety and access. Armour placement is expected to have significant negative medium term impact on both pedestrian and vehicular safety and access along the seaward fronting lane of the existing road. Access along this section of the road will be periodically obstructed by the movement of heavy equipment, for the duration of the activity.

Recommended Mitigation

- Pre-wash armour stone units prior to deployment/placement
- Contain pedestrian access to the landward side of the road, behind a separating temporary protective barrier/screen to reduce potential pedestrian/vehicular contact.
- Restrict traffic along the Cabrits junction road (into and out of Portsmouth) to a single lane on landward side of road.
- Control traffic flow either manually or with well synchronized temporary traffic lights at both ends of the affected stretch of road, restricting traffic to a single lane to ensure smooth, manageable, safe vehicular movement.

4.2.9 Roadway repair and realignment of junction

The existing T-junction between the main Cabrits Junction coastal road, and the secondary inland access road will be realigned and rebuilt to include a traffic island and an increased number of lanes entering and exiting the junction. In addition, the broken and eroded edge of the Cabrits Junction main road will be reinstated and the road will undergo some widening.

Road repair and junction realignment will not significantly impact circulation, longshore transport, wave processes and/or existing benthic marine habitats.

In the event of heavy rainfall, short-term moderate impact to nearshore water quality is possible. Heavy rainfall events can erode and transport exposed sub-base materials from the road surface, if the surface sealing has not yet occurred. Under such conditions, the leaching and suspension of fine particulates would cause nearshore water to become more turbid.

No significant impact is expected for offshore water quality. If there is continuous heavy rainfall, and a plume of fine particulates from the eroded road sub-base develops, there is the possibility of short-term, low impact to offshore water quality.

Road surface repair activity will significantly impair, in the medium term, pedestrian and vehicular safety along both the main Cabrits Junction road and the secondary road. Alongshore access will also suffer medium term impairment. However, in the long-term, the improved condition of the road and the realigned junction should serve to enhance the conditions of safety and access along the Cabrits Junction road.

During the course of the repair and realignment activity, the visual aesthetics of the project site will suffer moderate medium-term adverse effect. However, in the long-term the repair and realignment of the road is expected to enhance the aesthetics of the Cabrits Junction location.

Road repair and realignment is expected to produce moderate medium-term impacts with respect to generation of noise, dust and vibration. The impacts of noise and vibration are unavoidable. Because most residential communities are some distance removed from the project site the potential impacts of noise and vibration are mitigated somewhat. Vehicle drivers and pedestrians may be especially affected by dust emissions.

The repair of the roadway will provide long-term positive benefit to shoreline stability and integrity.

Recommended Mitigation

- The scheduling for this aspect of the works should be optimized in order to minimize the period that the use of the Cabrits Junction road is disrupted.
- Wet down the project site as frequently as necessary to reduce adverse effects associated with dust generation.
- All demolition/construction debris generated should be discarded in an acceptable manner at a site approved for the disposal of this type of waste.
- Restrict traffic into and out of Portsmouth to a single lane, with the lane position being alternated to accommodate road surface repair and resurfacing.
- During construction, control traffic flow either manually or with well synchronized temporary traffic lights at both ends of the affected stretch of road, restricting traffic to a single lane to ensure smooth, manageable, safe vehicular movement.
- Physically separate pedestrian from vehicular traffic, utilizing newly constructed sidewalk for pedestrians along the retaining wall.
- Appropriate signage should be erected in order to guide motorists as to right-of-ways and correct use of the improved junction.
- Landscaping the traffic island would contribute to improving the aesthetic attributes of the junction.
- Consideration should be given in the future to acquiring land on the landward side of the road to provide a shoulder that could be used for parking purposes. Such an exercise would assist in relieving traffic congestion, especially during holiday periods, that results from users of Purple Turtle Beach parking along the roadway.

4.3 Cabrits Access

4.3.1 Material stockpiling

Both armour stone and fill materials will have to be transported from remote quarry sites and stockpiled on-site for use. Depending on quarry location, and the condition of the roads on the route from the quarry to the Cabrits Access location, armour stone will be conveyed to site either by barge or by truck.

The use of barges is favored over the use of trucks. In order to reach the project location, trucks would have to travel via the Portsmouth Bridge, located to the north of the project site. This bridge was not designed to support such heavy traffic and as such may be damaged by the weight of the vehicles that would be necessary to transport the construction materials.

Should the barge option be implemented, a temporary landing ramp will have to be constructed out from shore. Construction of the landing ramp has the potential to moderately impact nearshore benthic marine habitat over the long term, depending on the exact site selected for the ramp. No impact is expected to offshore benthic marine communities.

Construction of the landing ramp may contribute to a decline in nearshore water quality depending on what substrate materials are used in its construction and their treatment. The use of fine materials has potential for the development of a nearshore sediment plume. No other significant water quality impacts from temporary ramp construction are anticipated.

Construction of the ramp may induce some short-term groyne effect by trapping littoral sediment drift.

At the conclusion of this activity, the landing ramp will be dismantled. Improper disposal of the materials used to construct the ramp has the potential to adversely affect the visual aesthetics of the disposal site. If the materials are disposed of in a sensitive habitat, whether terrestrial or marine, significant negative impacts on that habitat and associated communities may be expected.

The stockpiling activity itself is not expected to generate any significantly negative long-term or widespread impacts on coastal process, the natural environment and/or the built environment.

Negligible impacts on nearshore circulation, longshore drift and wave processes are expected from material stockpiling.

The potential for some moderate, short-term degradation of nearshore water quality exists if there is heavy rainfall and leaching of runoff from designated stockpile zones. Such impact would be primarily in the form of increased water column turbidity due to sediment loading.

Minimal, short-term impacts to offshore water quality may occur if runoff from the stockpile areas takes place.

Stockpiling and potential runoff has the potential to moderately impact nearshore benthic habitat in the short term. Potential impact to offshore habitat is expected to be negligible given the distance from shore where viable offshore habitats begins to occur.

No major negative impacts to terrestrial habitats are anticipated as a result of the stockpiling activity.

Localized, moderate medium-term disruptive impacts on pedestrian access and safety as well as vehicular access and safety are expected in the vicinity of the designated stockpile zone. Given the availability of space at the site, the most feasible location for stockpiling of the material is in the parking lot of the jetty located on the nearby Cabrits headland.

Recreational bathing and fishing will be unaffected by the stockpiling of material, as neither of these activities occurs within the project area.

Stockpiling can be expected to produce moderate medium-term impacts with respect to the generation of noise, dust and vibration. Noise and vibration cannot be avoided. Since most residential communities are some distance away from likely stockpile zones, however, these

impacts are not expected to be significant. Vehicular and pedestrian traffic may be similarly affected.

Stockpiling will impact negatively on the visual aesthetics of the project site in the medium-term, for the time that the armour stone and bedding material remain in place.

Stockpiling will have negligible impact on structural integrity of the existing seawall, as the stockpile is not expected to be located close to this structure.

Recommended Mitigation

- If a landing ramp is required due to the use of a barge to transport material to site, a ramp should be constructed using large, pre-washed stone (if possible) rather than with fine particle substrate materials;
- Landing ramp should be constructed at a location with minimal benthic coral cover. This can be confirmed by reconnaissance diving. Coral cover appears lowest in the nearshore in the vicinity of the jetty. Where there are stones with encrusting coral cover that can be manually removed, they should be relocated.
- If fine particle substrate materials are used to construct the temporary ramp, the edges must be contained with a geotextile, to prevent leaching of material into nearshore waters;
- "Groyne effect" of the ramp can be minimized if the ramp is kept short (i.e. it does not extend more than 15-20 metres from the shore), if loading and shore transfer of material is carried out rapidly and the ramp is removed immediately once the required material is stockpiled on site;
- In the event that a landing ramp is required, the armour stone used to build it should, wherever possible, be utilized at the construction site as part of the rock armouring protection of the seawall. If re-use in this or other construction projects is not feasible, the material be disposed of appropriately at a Government approved disposal site;
- When the landing ramp is dismantled, any structural fill used in its construction should be excavated and disposed of at the closest disposal site approved by the Government of Dominica;
- Armour stone units should be pre-washed to remove any particulate material that might adhere to the surface of the stones;
- Optimize the construction schedule to minimize residence time of material stockpile on site; and
- Surfaces of stockpiled rock for bedding layer can be periodically wetted to reduce suspension of fines by wind.

4.3.2 Excavation/Removal/Regrading/Reshaping of Existing Revetment

This activity will involve optimizing the existing structure, by removal of stones that do not meet design grade, repositioning of usable stones to facilitate the emplacement of a secondary base/foundation layer, and site preparation to accommodate geotextile placement.

No significant negative impacts to circulation, longshore sediment transport or wave processes are expected as a consequence of this activity.

A short-term decline in nearshore water quality is expected as a result of the excavation, removal, regrading and reshaping activities. This decline will largely be due to sediment suspension as a result of bottom substrate agitation. The impact will be minimal and will persist only for the duration of the activity.

Negligible impact is expected to offshore water quality, as this activity will be of short duration, localized and limited in spatial scale.

This activity has the potential to moderately, negatively impact nearshore benthic marine habitat over the medium term. Offshore benthic habitats are sufficiently far away so as not to be impacted.

No significant impact on terrestrial habitats is expected as a result of this activity.

This activity is expected to have some moderately adverse short-term impact on pedestrian and vehicular safety and access along the seaward fronting lane of the existing road. Access along this section of the road will be obstructed for the duration of the activity. Impaired access to the Cabrits National Park may cause some reduction in the number of visitors to the Park.

Fishing and recreational bathing do not occur in the project area, and will therefore be unaffected by the alterations to the existing revetment.

The visual aesthetics of the project site will be negatively impacted in the short-term by this activity.

Improper disposal of materials excavated and/or removed from the existing revetment may negatively impact the aesthetics of the location where they are discarded. Furthermore, there is the possibility that if these materials are disposed of in a sensitive habitat (whether marine or terrestrial), there may significant negative impacts on that habitat.

Recommended Mitigation

- Contain pedestrian access to the landward side of the road, behind a temporary protective barrier, to reduce potential pedestrian/vehicular contact;
- Restrict traffic along the Cabrits Access road to a single lane on the landward side of the road;
- Control traffic flow either manually or automatically with temporary traffic lights at both ends of the affected stretch of road, restricting traffic to a single lane and ensuring safe vehicular movement;
- Optimize the activity schedule to minimize the duration of disruption of access along the Cabrits Access road.
- All debris generated should be disposed of in an environmentally sound manner at an approved disposal site.

4.3.3 Retaining wall construction

The retaining wall at the Cabrits Access location will be a poured concrete structure.

Forms will be constructed or placed on site. Concrete will then be poured/cast into the forms, which are removed several days later. When complete, the wall will serve to retain the composite fill of the road, thus maintaining the integrity and consistency of the road's surface and sub-base. The new culvert will serve to maintain the existing drainage from the landward swamp to the nearshore region. The retaining wall structure will be additionally protected by the sloping armour stone revetment, which will absorb and dissipate the impact forces of incident waves.

Retaining wall construction is not envisaged to induce any significant negative impact to circulation, wave processes or longshore drift. Further, no significant impacts to nearshore benthic marine communities/habitats are also expected and those in the offshore are sufficiently far away so as not to be affected.

Some potential for localized short-term moderate impact to nearshore water quality exists, should there be any escape/leaching of concrete from the mould during casting. However, the probability of this occurring is low.

No significant impacts to offshore water quality are expected as a consequence of wall construction.

Significant medium term impact to both vehicular and pedestrian traffic and safety along the Cabrits Junction road are expected as a result of wall construction. Concrete trucks will cause disruptions, particularly during pouring. In addition the noise and vibration generated by the trucks may have some effect on the well-being of road users.

The retaining wall will provide significant long-term positive impact/benefit to shoreline integrity and stability.

Recommended Mitigation

- Vigilant inspection during concrete pouring to prevent "overpouring/overfilling"
- Contain pedestrian access to the landward side of the road, behind a separating temporary protective barrier/screen to reduce potential pedestrian/vehicular contact.
- Restrict inbound and outbound traffic along the Cabrits Access road to a single lane on landward side of road.
- Control traffic flow either manually or with well synchronized temporary traffic lights at both ends of the affected stretch of road, restricting traffic to a single, lane to ensure smooth, manageable, safe vehicular movement.
- Provide an elevated sidewalk alongside the crest of wall with railings for future pedestrian alongshore access. This will protect the long-term safety of pedestrian traffic.

4.3.4 Geotextile Placement

A layer of geotextile material will be installed prior to the placement of the secondary layer and the armour stone layer. This geotextile layer will extend from the base of the retaining wall to the toe of the revetment. It provides a barrier between the fine sediments of the underlying seabed and the overlying layers of stone, inhibiting the movement of fines from the base of the revetment, and preventing excessive settlement of the revetment.

The laying of the geotextile materials is not expected to cause any significant negative impacts on circulation, longshore sediment transport or wave processes.

No significant disturbance of bottom substrate or suspension of fine particles in the nearshore environment is expected as a result of this activity. Hence, impacts on nearshore water quality, if any, are predicted to be minimal and short-term.

No impacts on offshore water quality are expected as a result of this activity.

If the geotextile layer is allowed to extend too far into the nearshore zone, thus covering the benthic communities existing in that area, there is some potential for this activity to have a moderate negative impact on nearshore benthic marine habitat over the long term. Offshore benthic habitats and communities are sufficiently distant as to be unaffected by this activity.

The deposition of the geotextile layer is expected to have moderate negative short-term impact on both pedestrian and vehicular safety and access along the seaward fronting lane of both of the existing road, due to some obstruction of access for the duration of the activity.

Activities such as sea-bathing and fishing do not take place in close proximity to the project area and will therefore be unaffected by the placement of the geotextile layer.

The visual aesthetics of the project area will suffer some minimal short-term impact.

In the long-term, the placement of the geotextile layer will have a positive effect on shoreline stability and integrity.

Recommended Mitigation

- The geotextile layer should not extend beyond a distance of 12-15 metres from the location of the toe of the currently existing structure, so as not to encroach on existing viable nearshore benthic marine habitat.
- Contain pedestrian access to the landward side of the road, behind a separating temporary protective barrier/screen to reduce potential pedestrian/vehicular contact.
- Restrict traffic along the Cabrits Junction road (into and out of Portsmouth) to a single lane on landward side of road.
- Control traffic flow either manually or with temporary traffic lights at both ends of the affected stretch of road, restricting traffic to a lane to ensure smooth, manageable, safe vehicular movement.

4.3.5 Secondary Layer Placement

A secondary layer of 100-700kg stone will be deposited along the seaward side of the retaining wall, as a precursor to the construction of either a benched or sloping armour stone revetment. This layer is expected to extend to an approximate distance of 16 metres from the centre-line of the road into the immediate nearshore. It will be over-laid by layers of larger protective armour stone units. This layer will also serve as a temporary pad that the excavator and/or crane can uses to deploy and pack armour stone units.

The placement of the secondary layer is not expected to cause any significant negative impacts to circulation, longshore sediment transport or wave processes, as the activity is of limited spatial scale.

It is expected that the washing off and suspension of fines from the surface of the stone layer material may cause some moderate medium-term impact to nearshore water quality. There is potential for the development of a plume within the immediate nearshore. The plume is likely to persist for as long as it takes for the surface fines to be removed and dissipated.

Impacts on offshore water quality are expected to be minimal and short-term.

Unlike at Cabrits Junction, this activity has the potential to moderately negatively impact nearshore benthic marine habitat over the long term, either by direct physical coverage if it is allowed to extend too far into the nearshore zone or alternatively as a result of the formation of a plume from the suspension of fine particulates from the surfaces of the stones.

Secondary layer stone deposition is expected to have significant negative medium-term impacts on pedestrian and vehicular access and safety along the seaward lane of the existing road. Access will be obstructed for the duration of the activity.

It is expected that there will be a moderate negative impact on visual aesthetics for the duration of the activity.

Recommended Mitigation

- Underpin the seaward edge/toe of the secondary layer with geotextile fabric.
- The toe of the new structure should not extend beyond a distance of 12-15 metres from the location of the toe of the currently existing structure, so as not to encroach on existing viable nearshore benthic marine habitat.
- Contain pedestrian access to the landward side of the road, behind a separating temporary protective barrier/screen to reduce potential pedestrian/vehicular contact.
- Restrict traffic along the Cabrits Access road to a single lane on landward side of road.
- Control traffic flow either manually or with temporary traffic lights at both ends of the affected stretch of road, restricting traffic to a single lane to ensure smooth, manageable, safe vehicular movement.

4.3.6 Armour Stone Placement

Placement of additional armour stone will be necessary in order to increase the level of protection offered by the revetment that currently exists on the seaward edge of the Cabrits Access road, as well as supplementing deficits in the size of existing stone. Armour stone will be placed by a crane or excavator from the existing shore road or alternatively by clearing an area within the existing revetment structure, building in a temporary boulder pad, that can be progressively moved alongshore to complete the revetment. The enhanced revetment will extend a distance of 16 metres from the centre-line of the road into the nearshore.

It is expected that stones in the most seaward zones will be placed first, working backwards to the road. No significant differences with respect to potential environmental impacts are expected whether a benched or simple sloping revetment design is pursued. The former is likely to have a slightly increased footprint thus encroaching into the nearshore zone by a

few metres more. A benched revetment also generates less wave reflection than a simple sloping one.

Armour stone placement is not envisaged to induce any significant negative impact to circulation, wave processes or longshore drift. It will provide positive long-term benefit with respect to structural stability and integrity as well as wave energy dissipation.

Minimal short-term impacts to nearshore benthic marine communities are expected, providing that that the pad or revetment does not extend 12-15 metres seaward beyond the toe of the currently existing revetment structure. If the structure is built to design specification, more significant negative impact is unlikely to occur. Impacts on offshore benthic habitats are expected to be negligible.

Some localized impact to nearshore marine water quality may be expected from the suspension of fine surface adherent particulates when stones are deployed close to the water line. This impact is expected to short in duration and of minimal effect. No significant impact to offshore marine water quality is expected.

The main likely impacts arising out of armour stone placement will be to pedestrian and vehicular safety and access. Armour placement is expected to have significant negative medium term impact on both pedestrian and vehicular safety and access along the seaward fronting lane of the existing road. Access along this section of the road will be periodically obstructed, for the duration of the activity, by the movement of heavy equipment.

The operations of amenities within Cabrits National Park may also be affected by the reduced accessibility along the Access road during the revetment construction period.

Recommended Mitigation

- Pre-wash armour stone units prior to deployment/placement
- The toe of the new structure should not extend beyond a distance of 12-15 metres from the location of the toe of the currently existing structure, so as not to encroach on existing viable nearshore benthic marine habitat.
- If temporary pad is required for the crane, then large pre-washed armour stone should be used. If finer materials are to be used, then the edges should be treated with geotextile to prevent leaching into the nearshore.
- Contain pedestrian access to the landward side of the road, behind a separating temporary protective barrier/screen to reduce potential pedestrian/vehicular contact.
- Restrict traffic along the Cabrits Access road (into and out of Cabrits National Park) to a single lane on landward side of road.
- Control traffic flow either manually or with well-synchronized temporary traffic lights at both ends of the affected stretch of road, restricting traffic to a single lane to ensure smooth, manageable, safe vehicular movement.
- Optimize the scheduling for this activity in order to minimize the duration of disruption of traffic along the Cabrits Access road.

4.3.7 Spot Repair, Surface Elevation and Re-surfacing of Road

This work will involve selective excavation, infilling and compaction of localized sites of the road surface. The existing road surface will then be graded and the road will be re-surfaced to double surface dressing.

Road repair and re-surfacing will not significantly impact circulation, longshore transport, or wave processes.

Some short-term moderate impact to nearshore water quality could occur if heavy rainfall events are experienced. Such events can erode and transport exposed sub-base materials from the road surface if the surface has not yet been sealed. Under such conditions, nearshore water would become more turbid due to the leaching and suspension of fine particulates.

No significant impact on offshore water quality is expected. If there is continuous heavy rainfall and development of a plume, the possibility exists for short-term, minor impact to offshore water quality.

There is the potential for moderate short-term negative impact to nearshore benthic habitats if there are significant stormwater runoff events. No significant negative impacts to offshore benthic marine habitats are expected, as they are sufficiently distant from the work area.

In the long-term, the improved conditions of the road subsequent to repair and re-surfacing may make access to the Cabrits National Park more convenient.

Road surface repair activity will significantly obstruct pedestrian and vehicular safety and alongshore access in the medium-term. It will provide long-term positive benefits to shoreline stability and integrity.

Neither recreational swimming nor fishing take place within the project area and as such will be unaffected by these works.

Some moderate, medium-term negative impacts with respect to noise, dust and vibration emissions can be expected from road repair activity. Residential communities are sufficiently far away so as not to be significantly affected. Vehicle drivers and pedestrians may be affected, especially by dust emissions.

Some medium-term negative impact to visual aesthetics is anticipated as a result of road repair and resurfacing.

In terms of structural stability and shoreline integrity, significant long-term benefit from road repairs and resurfacing are expected.

Recommended Mitigation

- Wet the surface of the finer road base materials after it is placed and compacted;
- Seal and complete the road surface rapidly (i.e. as soon as repairs to each road section are completed);
- Prevent the leaching of asphalt into the nearshore zone.
- During construction, physically separate pedestrian from vehicular traffic by means of a separating temporary protective barrier/screen to reduce potential pedestrian/vehicular contact.

- Control traffic flow either manually or automatically (with well synchronized temporary traffic lights) at both ends of the affected stretch of road, restricting traffic to a single lane on the landward side of road. This will ensure smooth, manageable and safe vehicular movement. This lane should be alternated to accommodate road resurfacing; and
- Construct a sidewalk for pedestrians along the seaward side of the road, in the vicinity of the crest of the revetment.

5. Operation & Maintenance Impact Analysis

5.1 Cabrits Junction

An assessment of the environmental consequences of the operation and maintenance of road, seawall and revetment infrastructure is presented in the following sections.

5.1.1 Road

Once repair and surface treatment is completed, road operation is not expected to generate any significant negative impacts to nearshore circulation, longshore sediment transport and wave processes.

Some short term, moderate impact to nearshore water quality may occur from road surface runoff during elevated rainfall episodes. Under such conditions nearshore water quality will decline.

Impacts to offshore water are expected to be low and short term, and will only be experienced should diminished nearshore water quality conditions persist and move offshore.

Periodic short-term minimal impacts to nearshore habitat can be expected, as result of occasional elevated surface runoff events. No significant habitats that could be impacted exist in the nearshore and seagrass habitat is located sufficiently far offshore, so as not to be significantly negatively impacted.

The swamp on the landward side of the road represents a significant sensitive terrestrial habitat. Swamp habitats are not extensive in Dominica, and the swamp at the Cabrits Junction location is the largest of its kind in the island. The presence of the coastal road has historically impacted the swamp by reducing the interface between swamp and sea. With the construction of the sea defense systems and repair of the roadway at the Junction, current drainage routes from the swamp and landward areas to the nearshore environment will be maintained. It is not anticipated that the operation of the realigned road at the Cabrits Junction site will have any significant impacts on the swamp habitat beyond those that have been in place since the coastal road was originally constructed.

Repair of and improvements to the road surface are expected to improve vehicular and pedestrian access and safety. The improvements to the intersection between the main coastal road and the secondary road will assist in optimizing the traffic flow between the main Cabrits Junction road and the secondary road.

The potential conflict between pedestrian and vehicular use of the road should be significantly reduced with the provision of a sidewalk/pavement at one side of the road, as recommended in the mitigation measures for the construction of the retaining wall.

Long-term improvements in visual aesthetics are also expected as a result of road repair and surface treatment.

Long-term improvement in structure stability and shoreline integrity is envisaged.

5.1.2 Retaining Wall

On completion, the retaining walls are not expected to generate any direct or indirect significant negative biophysical, coastal process or habitat impacts. The presence of the retaining walls will provide long-term benefit with respect to wave force dissipation.

No impacts to terrestrial and marine habitats are forecasted.

The presence of the retaining wall will enhance pedestrian and vehicular access and safety by preventing the leaching of fine materials from the sub-base of the road, thus maintaining the integrity of the road.

Visual aesthetics are also expected to improve as a result of the construction of the retaining walls.

Structural stability and shoreline integrity will also be improved as a result of retaining wall construction.

5.1.3 Revetment

The completed revetment is not expected to generate any significant adverse biophysical, coastal process or habitat impacts.

The revetments will serve to absorb and further enhance the dissipation of incident wave energy approaching the roads at both project sites. This will offer the roads significantly increased protection from wave attack and scour, particularly during higher energy wave events.

The revetment structure will impair alongshore pedestrian access at the level of the beach due to its physical presence. This may only occur periodically as a majority of the structure may be partially buried, only being occasionally exposed with beach excursions induced due to the passage of high than normal wave energy events.

The revetments will enhance pedestrian and vehicular safety and access along the road edge as a consequence of the increased level of protection they offer against wave attack and scour.

The visual aesthetics of the shorelines may be impaired over the long term by the presence of the revetment structure.

Structural stability of the roads and the retaining wall will be increased due to the presence of the revetment.

5.2 Cabrits Access

An assessment of the environmental consequences of the operation and maintenance of the road, seawall and revetment infrastructure is presented in the following sections.

5.2.1 Road

Road operation, once repair and surface treatment is complete, is not expected to generate any significant negative impacts to nearshore circulation, longshore sediment transport and wave processes.

Some short-term, moderate impact to nearshore water quality may occur from road surface runoff during episodes of elevated rainfall. Under such conditions, nearshore water quality will decline.

Impacts to offshore water quality are expected to be low and short-term, and will only be experienced if diminished nearshore water quality conditions persist and move offshore.

The potential exists for minimal short-term negative impacts to nearshore benthic habitat as a result of periodic elevated stormwater runoff events from the road.

No major negative impacts to the terrestrial habitat of the Cabrits National Park are anticipated as a result of the operation of the road.

Vehicular access and safety is expected to improve with repair and improvements to the road surface. The potential conflict between pedestrians and vehicles is expected to be significantly reduced with the provision of a sidewalk along the seaward side of the road in the vicinity of the crest of the revetment. There is the potential for occasional rock fall from the steep cliff along the landward side of the road, thus presenting a hazard to vehicular and pedestrian users of the road. Although beyond the scope of this project future consideration might be given to reducing this danger by terracing or benching the cliff. This would involve the removal of vegetation from the cliff top, which falls within the domain of the Cabrits Natural Park. In the meantime it is recommended that signage be erected indicating the potential danger of falling rocks, and suggesting no stopping along the road at any time.

Recreational swimming and fishing will be unaffected, as neither activity is undertaken within the immediate nearshore of the project site.

Moderate long-term noise, vibration and dust emission impacts consistent with daily major road use are expected.

Visual aesthetics are expected to improve in the long term as a result of road repair and surface treatment.

Long-term improvement in structural stability and shoreline integrity is anticipated.

5.2.2 Retaining Wall

On completion, the retaining wall is not expected to generate any significant negative impacts on coastal processes, benthic or terrestrial habitats.

No impacts to nearshore or offshore marine water quality are expected.

No impacts to terrestrial and marine habitats are anticipated.

The presence of the retaining wall will enhance pedestrian and vehicular access and safety by preventing the leaching of fine materials from the sub-base of the road, thus maintaining the integrity of the road.

Recreational swimming and fishing will not be impacted by the presence of the retaining wall.

Visual aesthetics are expected to improve over the long-term as a result of wall construction.

5.2.3 Revetment

On completion, the revetment is not expected to generate any significant biophysical, coastal process impacts.

The revetment will serve to absorb and further enhance the dissipation of incident wave energy approaching the road. This will offer the road significant protection from wave attack and scour, particularly during wave higher energy events.

The presence of the revetment structure is not expected to impact nearshore or offshore marine water quality. Similarly, all habitats, nearshore, offshore and terrestrial, will be unaffected.

The revetment will enhance pedestrian and vehicular safety and access along the road edge as a result of the increased level of protection it offers from wave attack and scour.

Recreational swimming will not be impacted by the presence of the revetment. Similarly, fishing will be unaffected as these activities are not prevalent/common to the Cabrits Access locale.

No significant noise, dust or vibration impacts are expected once the revetment is in place.

The visual aesthetics of the shoreline will be altered over the long-term by the presence of the revetment structure. Structural stability of the road and the retaining wall will be significantly increased over the long term due to the presence of the revetment.

6. Monitoring of Mitigation Measures

Implementation of the recommended mitigations measures will be addressed at two levels. First, the recommendations will be incorporated into the Contract Documents as part of the General Conditions and as part of the Technical Specifications for each construction activity. Second, regular site inspections will be made to ensure compliance. The Environmental Specialist will be making an initial inspection at the start of construction to point out the clauses in the Contract and to instruct the site supervisor in addressing environmental matters. In addition, the Environmental Specialist will be making monthly inspections to ensure that the Contractor is in compliance with the recommendations.

7. List of Preparers

The following individuals were involved in the preparation of this report.

Name	Qualification
Mr. Yuri Chakalall	Environmental Specialist - Coastal zone and fisheries management
Dr. David Smith	Senior Coastal Engineer/Team leader
Mr. Philip Warner	Coastal Engineer
Mrs. Corinne Smith	Secretary /Editor

Detailed descriptions of areas of expertise, experience and professional discipline for these individuals can be furnished on request and were included in the technical proposal.

Appendix 1
EIA Matrix: Cabrits Junction and Access

No effect
Minimal effect
Moderate effect
Significant effect
Significant positive effect
ST = Short Term
MT = Medium Term
LT = Long Term

Areas of Potential Coastal Environmental Impacts

		PROJECT DEVELOPMENT ACTIVITY STAGES: CABRITS JUNCTION												
		Site Preparation &Construction									**Operation & Maintenance**			
		Removal of Boat from Beach	Material Stockpiling	Demolition & Clearance of Existing Wall Etc.	Retaining Wall & Culvert Construction	Beach/Nearshore Excavation	Geotextile Placement	Secondary Layer Placement	Primary Layer Armour Stone Placement	Roadway ReConstruction & Junction Realignment	Road	Seawall	Revetment
Physical	Water Circulation												
	Sediment Transport												
	Wave Processes								LT+			LT+	LT+
	Nearshore Water Quality		ST	ST	ST	ST	ST	MT	ST	ST	ST		
	Offshore Water Quality		ST			ST		ST		ST	ST		
Ecolog-ical	Nearshore Benthic Habitat												
	Offshore Benthic Habitat		ST			ST		ST					
	Terrestrial Habitat												
Social	Pedestrian Access	ST	MT	ST	MT	ST	ST	MT	MT	MT	LT+	LT+	LT+
	Pedestrian Safety	ST	MT	ST	MT	ST	ST	MT	MT	MT	LT+	LT+	LT+
	Vehicular Access	ST	MT	ST	MT	ST	ST	MT	MT	MT	LT+	LT+	LT+
	Vehicular Safety	ST	MT	ST	MT	ST	ST	MT	MT	MT	LT+	LT+	LT+
	Recreational Swimming			ST							ST		
	Fishing												
	Noise	ST	ST	ST	ST	MT		MT	MT	MT	LT		
	Dust		ST	ST				MT	MT	MT	LT		
	Vibration		ST	ST	ST	MT		MT	MT	MT	LT		
Built Env.	Aesthetics	LT+	MT	ST	ST	MT	ST	MT	MT	MT	LT+	LT+	LT
	Structural Stability & Shoreline Integrity				LT+		LT+	LT+	LT+	LT+	LT+	LT+	LT+

No effect
Minimal effect
Moderate effect
Significant effect
Significant positive effect
ST = Short Term
MT = Medium Term
LT = Long Term

	Areas of Potential Coastal Environmental Impacts	PROJECT DEVELOPMENT ACTIVITY STAGES: CABRITS ACCESS ROAD									
		Site Preparation &Construction							Operation & Maintenance		
		Material Stockpiling	Modification of Existing Revetment	Retaining Wall Construction	Geotextile Placement	Secondary Layer Placement	New Armour Stone Placement	Road Spot Repair, Surface Elevation & Resurfacing	Road	Seawall	Revetment
Physical	Water Circulation										
	Sediment Transport										
	Wave Processes						LT+			LT+	LT+
	Nearshore Water Quality	ST	ST	ST	ST	MT	ST	ST	ST		
	Offshore Water Quality	ST				ST		ST	ST		
Ecological	Nearshore Benthic Habitat	ST	MT		LT	LT	ST	ST			
	Offshore Benthic Habitat					ST					
	Terrestrial Habitat										
Social	Pedestrian Access	MT	ST	MT	ST	MT	MT	MT	LT+	LT+	LT+
	Pedestrian Safety	MT	ST	MT	ST	MT	MT	MT	LT+	LT+	LT+
	Vehicular Access	MT	ST	MT	ST	MT	MT	MT	LT+	LT+	LT+
	Vehicular Safety	MT	ST	MT	ST	MT	MT	MT	LT+	LT+	LT+
	Recreational Swimming								ST		
	Fishing										
	Noise	MT	ST	ST		MT	MT	MT	LT		
	Dust	MT	ST			MT	MT	MT	LT		
	Vibration	MT	ST	ST		MT	MT	MT	LT		
Built Env.	Aesthetics	MT	ST	ST	ST	MT	MT	MT	LT+	LT+	LT
	Structural Stability & Shoreline Integrity			LT+	LT+	LT+	LT+	LT+	LT+	LT+	LT+